CLAIMS

What is claimed is:

1. A **dynamically re-configurable** internal combustion engine coupled to operation of a vehicle comprising:

one or more cylinder units each with expanding and contracting cylinder volume and associated stroke sequences;

each cylinder unit having an intake port and an electronically controllable intake valve component having multiple states under computer control;

each cylinder unit having an exhaust port and an electronically controllable exhaust valve component having multiple states under computer control;

each cylinder unit having an electronic fuel injector component having multiple states under computer control;

each cylinder unit having an air-fuel mixture ignition means for igniting an air-fuel mixture in the cylinder volume, said ignition means under computer control;

each cylinder unit having a switch for selecting a first stroke sequence for combusting a compressed air-fuel mixture for a power stroke and for selecting a second stroke sequence for expelling compressed air for alternate use, said switching means under computer control;

a computer usable medium; and

a computer control system comprising computer readable program logic

embodied in the computer usable medium for controlling the steps of selecting component states to provide alterable cylinder unit stroke sequences.

2. A dynamically re-configurable internal combustion engine as in claim 1 further comprising programmable computer means for starting, transitioning and controlling individual cylinder units for selected modes of operation, wherein a mode is comprised of a sequence of piston strokes in concert with associated cylinder unit component states, said modes selected from, but not limited to; power mode, boost power mode, re-generative compression brake mode, compression brake mode, compressed air start mode and compressed air idle mode.

3. A dynamically re-configurable internal combustion engine as in claim 1 further comprising a program logic computer alterable engine cylinder unit firing order.

4. A dynamically re-configurable internal combustion engine as in claim 1 further comprising a cylinder unit power mode wherein execution of program logic controls cylinder unit component states in accordance with program logic defining the states sequentially set in concert with the cylinder unit piston position to create an intake, compression, power and exhaust stroke sequence.

5. A dynamically re-configurable internal combustion engine as in claim 1 further comprising a compressed air storage reservoir charged by one or more cylinder units having an associated valve component allowing compressed air to flow from a cylinder unit to the compressed air storage and an associated valve component having multiple states under computer control for metering compressed air from the compressed air storage reservoir to a cylinder unit.

6. A dynamically re-configurable internal combustion engine as in claim 5 further comprising electronically controllable compressed air injection quantity and electronically controllable fuel injection quantity for a computer programmably selectable air-fuel composition in cylinder unit.

7. A dynamically re-configurable internal combustion engine as in claim 5 further comprising engine compressed air start mode for initiating engine crankshaft rotation through admission of compressed air into volume expanding cylinder units in accordance with compressed air start mode logic and computer program logic execution responsive to engine speed and crankshaft position.

8. A dynamically re-configurable internal combustion engine as in claim 5 further comprising engine re-generative compression brake mode wherein a computer controls cylinder unit component states to sequence the cylinder unit to drawn air, compress the air using crankshaft to piston power obtained from vehicle inertia, and store it in compressed air storage reservoir for alternate use.

9. A dynamically re-configurable internal combustion engine as in claim 5 further comprising engine boost power mode wherein a computer controls cylinder unit component states to meter compressed air quantity and to meter fuel quantity into cylinder unit at programmable air-fuel mixture levels for power stroke.

10. A dynamically re-configurable internal combustion engine as in claim 5 further comprising engine compressed air idle mode for maintaining engine crankshaft rotation through admittance of compressed air into volume expanding cylinder unit in accordance with compressed air idle mode logic and computer program logic execution responsive to engine speed and crankshaft position.

11. A dynamically re-configurable internal combustion engine as in claim 5 further comprising mixed mode operation wherein one or more cylinder units operate in a mode different from but in concert with, one or more alternate engine cylinder units, by electronically controlling cylinder unit component states in accordance with programmed mode logic responsive to engine speed and crankshaft position.

12. A dynamically re-configurable internal combustion engine coupled to operation of a vehicle comprising:

one or more cylinder units each with expanding and contracting cylinder volume and associated stroke sequences;

each cylinder unit having an intake port and an electronically controllable intake valve component having multiple states under computer control;

each cylinder unit having an exhaust port and an electronically controllable exhaust valve component having multiple states under computer control;

each cylinder unit having an electronic fuel injector component having multiple states under computer control;

each cylinder unit having an air-fuel mixture ignition means for igniting an air-fuel mixture in the cylinder volume, said ignition means under computer control;

each cylinder unit having a switch for selecting a first stroke sequence for combusting a compressed air-fuel mixture for a power stroke and for selecting a second stroke sequence for expelling compressed air for alternate use said switching means under computer control;

a compressed air storage reservoir charged by one or more cylinder units having an associated valve component for flowing compressed air from a cylinder unit to the compressed air storage and associated valve components having multiple states under computer control for metering compressed air from the compressed air storage into cylinder unit;

a computer usable medium; and

a computer control system comprising computer readable program logic embodied in the computer usable medium for controlling the steps of selecting component states to provide alterable cylinder unit stroke sequences.

13. A dynamically re-configurable internal combustion engine coupled to operation of a vehicle comprising:

one or more cylinder units each with expanding and contracting cylinder volume and associated stroke sequences;

each cylinder unit having an intake port and an electronically controllable intake valve component having multiple states under computer control;

each cylinder unit having an exhaust port and an electronically controllable exhaust valve component having multiple states under computer control;

each cylinder unit having an electronic fuel injector component having multiple states under computer control;

each cylinder unit having an air-fuel mixture ignition means for igniting an air-fuel mixture in the cylinder volume, said ignition means under computer control;

each cylinder unit having a switch for selecting a first stroke sequence for drawing air into cylinder and for selecting a second stroke sequence drawing a vacuum in cylinder, said switch under computer control;

a computer usable medium; and

a computer control system comprising computer readable program logic embodied in the computer usable medium for controlling the steps of providing cylinder unit stroke sequences for generating crankshaft power in the first stroke sequence or vacuum for alternate use in the second stroke sequence.

14. An internal combustion engine operable in a power-generating mode and an air-compressing mode, comprising:

cylinder having a reciprocating piston to define a cylinder volume that expands and contracts;

an intake port and valve coupled to the cylinder for providing air to the cylinder volume;

an exhaust port and valve coupled to the cylinder for exhausting gases from the cylinder volume;

a fuel injector coupled to the cylinder for injecting fuel into the cylinder volume;

an ignition means coupled to the cylinder for igniting an air-fuel mixture in the cylinder volume;

a compressed air port and valve coupled to the cylinder for exhausting compressed air from the cylinder volume;

means coupled to the valves for selectively activating the intake and exhaust valves and closing the compressed air valve in the power-generating mode and for selectively activating the intake and compressed air valves and closing the exhaust valve in the air-compressing mode.

15. A method of dynamically re-configuring an internal combustion engine coupled to operation of a vehicle, the internal combustion engine being operable in a plurality of modes, the method comprising:

electronically controlling one or more cylinder unit associated valve, fuel injection and fuel ignition component states;

electronically synchronizing cylinder unit piston position with cylinder unit associated component states to create selected cylinder unit strokes;

embodying sequences of strokes defining a plurality of modes into computer readable program logic in computer usable medium;

embodying computer readable program logic in computer usable medium to determine engine operation requirements based in part on sensed signals and vehicle operational parameters;

selecting cylinder unit operating modes based in part on the determined engine operation requirements and program logic; and

configuring cylinder unit component states based in part on the selected sequence of cylinder unit strokes in accordance with the computer programmed selected mode of operation.

16. The method according to claim 15, wherein determining the engine operation mode comprises the steps of:

determining if the vehicle engine is on, and if not, then selecting Compression Start Mode if there is sufficient available source of compressed air, and alternatively executing a battery engine start;

determining the vehicle power requirements from real-time vehicle operating parameters and selecting engine Power Mode and alternatively, Boost Power Mode if the magnitude of the vehicle power requirement exceeds a given threshold and there is sufficient available source of compressed air to provide the required engine power;

determining the vehicle braking requirements from real-time vehicle operating parameters and selecting Re-Generative Compression Braking Mode operation if there is available compressed air storage capacity and alternatively, Compression Braking Mode, to provide the required engine braking power;

determining if the vehicle is required to be in hot standby and selecting Compressed Air Idle Mode if there is sufficient available source of compressed air and alternatively, Power Mode, to provide engine idling; and

systematically and continuously cycling through the comprised steps until an engine stop signal is received.

17. The method according to claim 15, further selecting from a plurality of modes whether the engine Compressed Air Production Mode is required comprises the steps of:

determining if the vehicle engine is on, and if not, then selecting Compression Start Mode if there is sufficient available source of compressed air and alternatively, a battery powered start;

determining if the engine must provide a source of compressed air for standalone application and selecting Compressed Air Production Mode until standalone application stop signal is received.

18. The method according to claim 15, wherein operation of Power Mode for a specified cylinder unit comprises the steps of:

determining engine speed required;

determining engine crankshaft position;

determining cylinder unit component state timing and duration from programmable logic for the power mode stroke sequence;

determining the cylinder unit inlet valve opening time and duration from engine parameters for the stroke sequence;

determining the cylinder unit exhaust valve opening time and duration from engine parameters for the stroke sequence;

determining the cylinder unit fuel injection time and duration for the engine speed required;

determining the cylinder unit fuel mixture ignition time and composition based on power stroke timing and engine speed requirements; and

sending output signals to cylinder unit components in accordance with determined timing and duration of component states for the intake, compression, power and exhaust stroke sequence.

19. The method according to claim 15, wherein a compressed air storage reservoir allows operation of, but not limited to, programmed modes of operation such as Regenerative Compression Brake Mode, Compressed Air Start Mode, Compressed Air Idle Mode, Boost Power Mode and Compressed Air Production Mode, comprising the steps of:

configuring one or more cylinder units to set component states in concert with a programmed sequence of strokes to expel compressed air from cylinder units to a compressed air storage reservoir; and

configuring one or more cylinder units to set component states in concert with a programmed sequence of strokes to received metered compressed air from a compressed air storage reservoir;

whereby programmed modes of engine operation which expel and receive compressed air have a respective storage and supply of compressed air.

20. The method according to claim 15, wherein the engine cylinder unit programmably alterable firing order comprises the steps of:

determining power requirements;

determining the cylinder units selected for power mode and boost power mode based partly on vehicle operating parameters; and

configuring cylinder unit operation by executing programmed logic defining power mode and boost mode cylinder unit component states with respect to selected stroke sequences;

wherein the firing order of the engine cylinder units which are programmed for power mode and boost power are independently controlled in accordance with program logic and vehicle parameter input.

21. A method for controlling a dynamically re-configurable internal combustion engine coupled to operation of a vehicle comprising:

determining if the vehicle engine is on, and if not, then selecting Compression Start Mode if there is sufficient available source of compressed air, and alternatively executing a battery engine start;

determining the vehicle power requirements from real-time vehicle operating parameters and selecting engine Power Mode and alternatively, Boost Power Mode if the magnitude of the vehicle power requirement exceeds a given threshold and there is sufficient available source of compressed air to provide the required engine power;

determining the vehicle braking requirements from real-time vehicle operating parameters and selecting Re-Generative Compression Braking Mode operation if there is available compressed air storage capacity and alternatively, Compression Braking Mode, to provide the required engine braking power;

determining if the vehicle is required to be in hot standby and selecting Compressed Air Idle Mode if there is sufficient available source of compressed air and alternatively, Power Mode, to provide engine idling; and

systematically and continuously cycling through the above steps until an engine stop signal is received.